Space Weather Technical Forecast

Issued on Tuesday, 23 April 2024 at 01:57 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Further M-class flares expected (R1/R2 blackouts). Slight chance of isolated G1/Minor Storm intervals throughout from peripheral CME effects.

IMPORTANT NOTICE: On the 23rd of April between 1500 UTC and 2100 UTC, a significant data outage at NOAA SWPC is expected which will impact most of our observational data feeds and some models. We may receive data intermittently through that period. MOSWOC service will continue on contingency. Alerts and warnings will be sent using alternative data, if available. The planned data outage may be postponed in the event of significant space weather.

Solar Activity: Moderate with several M-class flares observed. The largest observed reaching M2.8 at 22/1550UTC from a combination of AR3638 in the southwest and AR3656 in the far east. Fifteen sunspot regions feature on the visible side of the solar disc. This includes a broad complex in the southwest; including AR3638/45/47/43, these carry the majority of current flare risk, with the spots magnetically connected and complex in places. Several other regions are also moderately sized, but remain more stable with a simpler bipolar configurations. Several areas in the southeast remain small, but some developments continue to be observed, especially in relation to AR3654. The small AR3657 was numbered.

No clearly Earth directed CMEs observed in available imagery although analysis continues into a recent CME associated with a M1.6 flare from AR3638 at 22/2116UTC, likely associated with a 395km/s type II radio emission.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 were slightly elevated throughout, on a slowly declining trend, ending the period at around 400km/s. Below average density throughout. The Interplanetary Magnetic Field (IMF) Bt, was weak 3-8nT, with the north-south component, Bz, varying weakly between -5/+6nT. Phi angle was predominately negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was at Background. High energy electron flux (greater than 2MeV) observed at GOES16 was initially at Background, but rose to become Moderate from around 22/0800UTC. The associated 24-hour fluence remained below Active (1e8 integrated flux), but with a rising trend, reaching 1.61e7 integrated pfu at 23/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Occasional M-class flares are expected to continue, with a slight chance of isolated X-class flares. The greatest risk from the large complex of sunspots in the southwest.

Solar Wind / Geomagnetic Activity: There are several CMEs that are anticipated to pass close to the Earth through the period, with potential of glancing interactions. This gives low confidence to the detail for the geomagnetic forecast. Slightly elevated solar winds resulting from CH25/- are expected to gradually decline towards slow-ambient levels in coming days. A further

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enhancement possible by day 4 (26 Apr) in association with CH27/+ currently near centre disk, perhaps seeing winds increasing back towards slightly elevated or elevated levels.

Overall, geomagnetic activity starting Quiet to Unsettled at first, but declining to mainly Quiet with isolated Unsettled intervals into day 1 (23 Apr). Any CME arrivals however, will give a chance of further isolated Active intervals and a slight chance of G1 Minor Storms. Activity perhaps more generally increasing by day 4 (26 Apr) with Unsettled to Active conditions expected by the end of the period given positive HSS influence.

Energetic Particles / Solar Radiation: High energy proton flux is expected to be at background, but with a chance of rising in response to any large flares that occur, predominately from the complex of sunspots in the southwest. This bringing a slight chance of reaching the S1 Minor Radiation Storm threshold throughout.

High energy electron flux as observed by GOES16 is expected to display a slowly rising trend, increasingly Moderate and likely peaking at High diurnal values, however this may be limited by any glancing CME impacts that occur. The associated 24-hour electron fluence is expected to remain generally below the Active (1e8 integrated pfu) threshold but with a rising trend, giving an increasing chance of reaching the Active threshold by days 2-3 (24-25 Apr).

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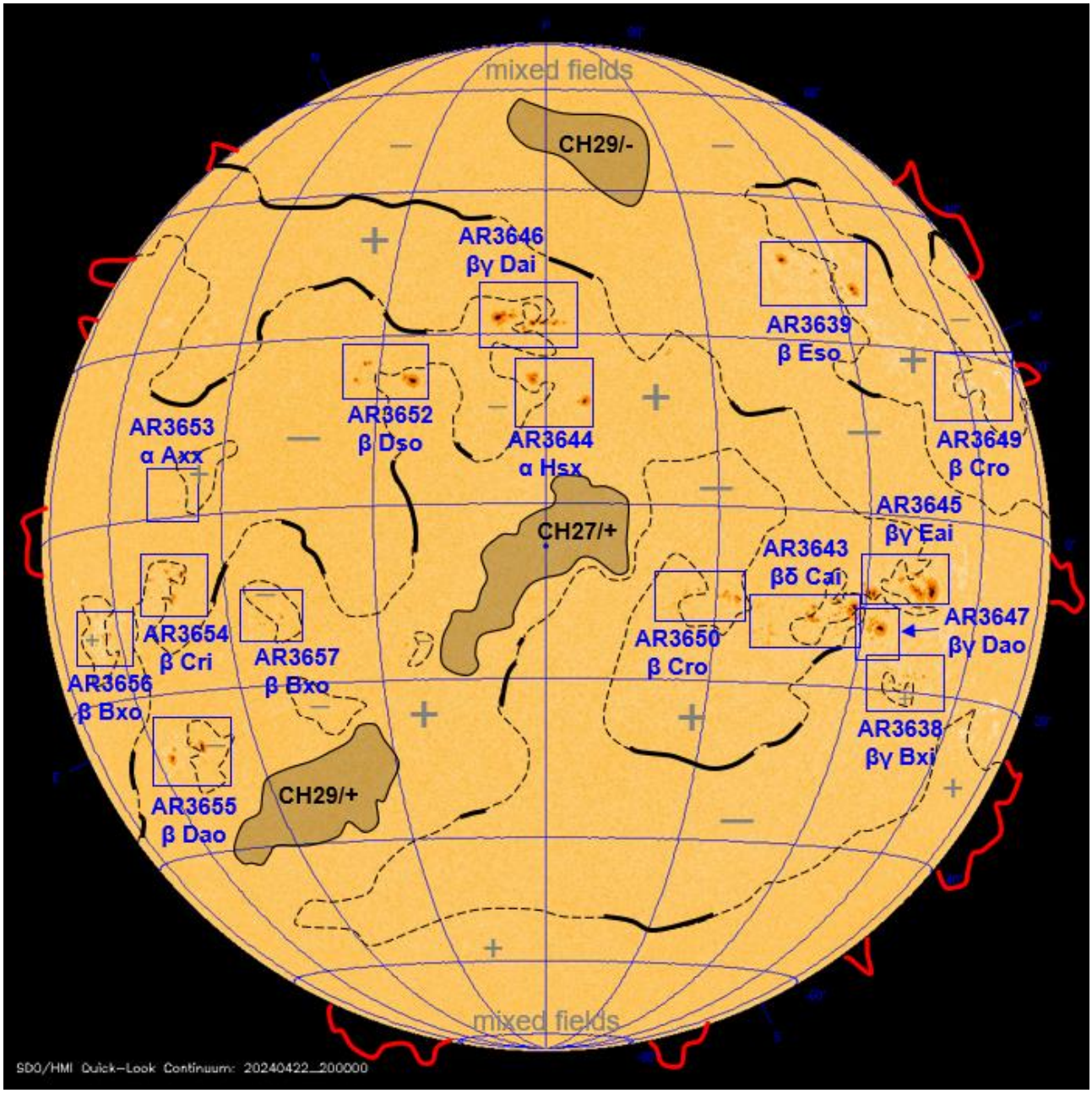
Figure 1. Solar Analysis Valid 22/2000UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Multiple CMEs associated with the complex sunspot region in the southwest have been observed in recent days. Analysis and model output suggests CMEs may pass close to Earth through the period, largely glancing to the south. These CMEs may be too weak for much of a noticeable impact, but there is the potential for an increase in geomagnetic activity from any glances that occur, particularly later in the period.

Solar winds at slightly elevated levels at first, most likely due to the slowly waning connection of CH25/-. These winds are likely to gradually ease to slow-ambient wind conditions in the absence of CME enhancement, as supported by MOSWOC Enlil. A further enhancement possible by day 4 (26 Apr) in association with CH27/+ currently near centre disk, perhaps seeing winds increasing back towards slightly elevated or elevated levels.

Overall, geomagnetic activity starting Quiet to Unsettled at first, but declining to mainly Quiet with isolated Unsettled intervals into day 1 (23 Apr). Any CME arrivals however, will give a chance of further isolated Active intervals and a slight chance of G1 Minor Storms. Activity perhaps more generally increasing by day 4 (26 Apr) with Unsettled to Active conditions expected by the end of the period given positive HSS influence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	10	15	15
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

There are a number of weak CMEs either passing close by, or perhaps giving slight glancing interactions at Earth. These have occurred primarily from AR3638, but also other regions within the southern disc. These all combine to give a broad range of potential glancing impacts, as shown in the ensemble in figure 2 below, with further CMEs from the 22 Apr still yet to be assessed.

Figure 2: Latest MOSWOC ENLIL ensemble output. Note that the potential enhancement from CH27/+ late in the period may be underrepresented.

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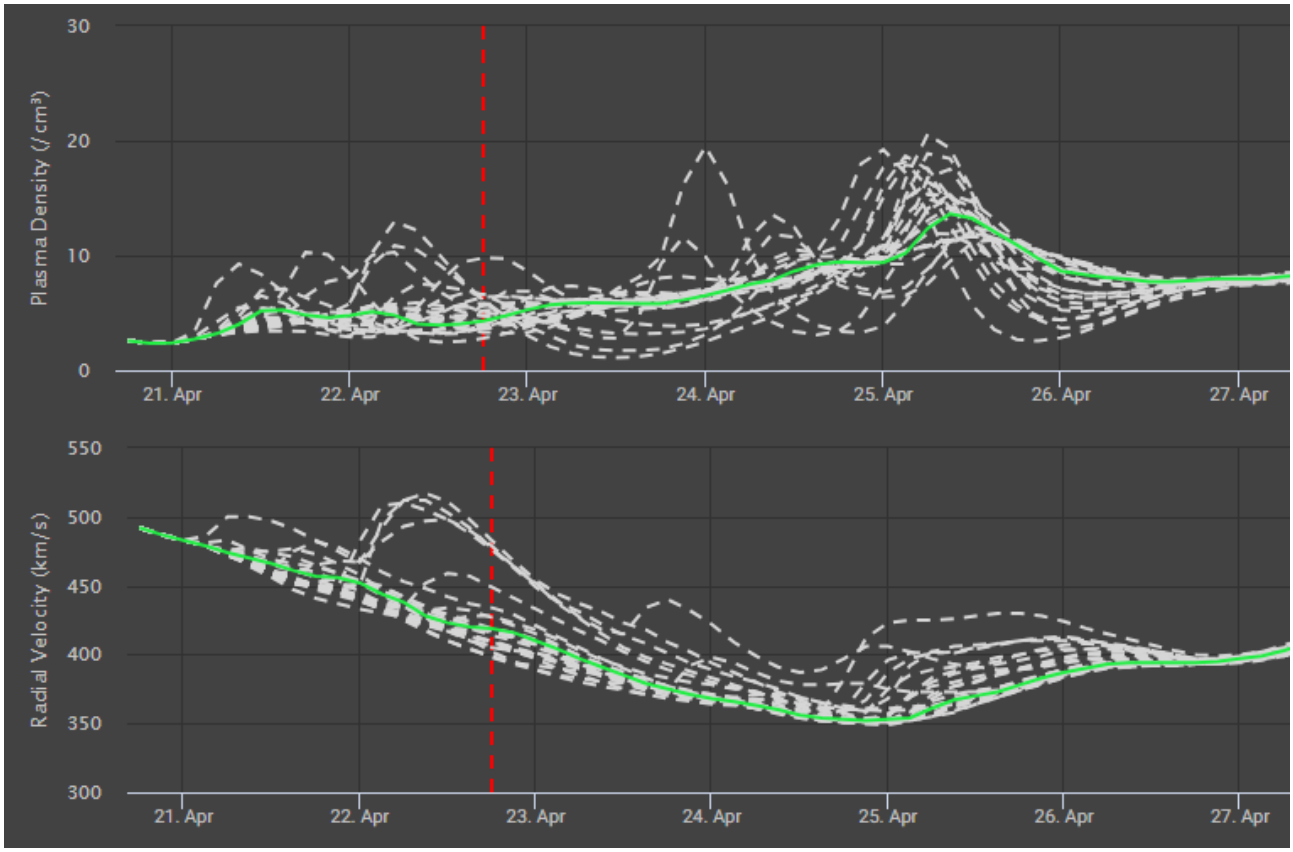

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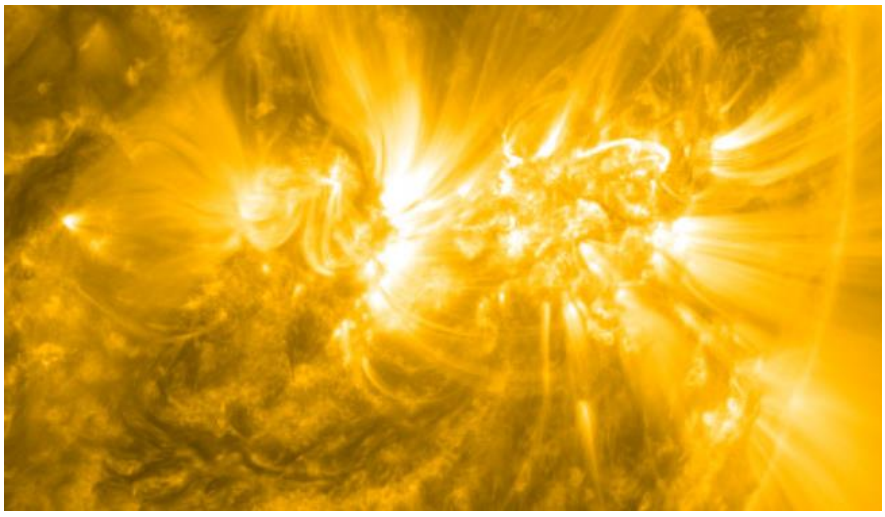
Radio Blackouts - X-Ray Flares:
Moderate activity is expected to continue through this guidance period, with occasional M-class flares expected and a slight chance of isolated X-class flares.

There are fifteen active regions on the visible disc. This includes a broad complex located across the southwest of the visible disc, including AR3638/45/47/43, which continue to collectively provide the main source of flare activity. This is due to an overarching magnetic structure connecting many of the spots, as evidenced from SDO imagery, along with some mixing of the magnetic polarities. This complex provides the main potential for any isolated X-class flares given the total available flux, although so far fairly frequent lower level M-class flares may be helping to dissipate energy somewhat. The complex as a whole will be begin to approach the western limb by day 4 (26 Apr) but will present a flare risk throughout the period depending on further developments.

Several other regions are also moderately sized on the disk, but remain more stable currently with a simpler bipolar configurations. Small areas of flux emergence and spot growth are visible in the southeast however, with a number of new small regions recently numbered. No significant returning regions expected during the period or currently signaled on far side sounding data.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: Latest SDO/AIA 171 imagery of the southwest complex, showing broad looping across multiple active regions



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Solar Radiation Storms - (High Energy Protons):
High energy proton flux as observed by GOES18 has persisted at Background. There remains a slight chance of enhanced flare activity, primarily from the cluster of sunspot in the southwest disc, which could increase the proton flux at Earth. This bring a slight chance of reaching the S1 Minor Solar Radiation Storm level throughout the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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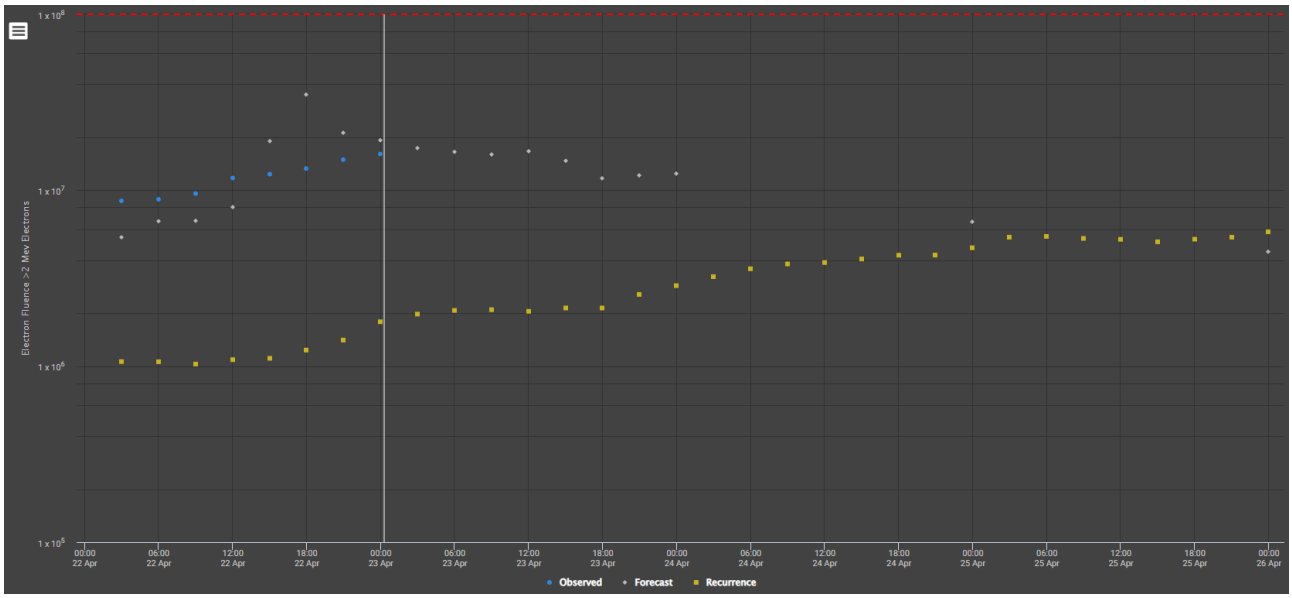
High Energy Electrons Event (≥ 2MeV):
High energy electron flux as observed by GOES16 rose to persistent Moderate levels during 22 Apr, likely as a result of the recent CME arrival and HSS onset that had been observed on previous days. As solar winds likely continue to slowly ease, any charging that has occurred at lower L-shells is expected to become increasingly relevant at GEO, with the observed flux increasingly likely peaking at High levels during diurnal maxima into the coming period. This is only moderate confidence however, as the arrival of any CMEs and associated geomagnetic activity may help to modulate the observed flux, and any more notable arrivals have the potential to drop values back towards background. Any HSS by the end of the period will also bring a similar possibility.

The associated 24 hour electron fluence is thus expected to continue on a generally upward trend, as indicated by Met Office REFM output, which looks to be providing reasonable guidance in the absence of any CME arrivals, but likely under-estimating peak values. This will give a slight, but increasing chance of reaching the Active threshold by day 2-3 (25-26 Apr), although this potential will reduce should any dropout from any CME arrival occur and remains only moderate confidence, particularly by the end of the period given potential HSS influence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	25	30	25
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Latest MOSWOC REFM output



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